VII. "Experiments on Fluid Viscosity." By A. MALLOCK. Communicated by LORD KELVIN, P.R.S. Received July 26, 1895.

(Abstract.)

The paper gives an account of a series of experiments on the viscosity of water made with revolving cylinders. The cylinders were coaxial, and the fluid was placed in the annulus between them. Special precautions were taken to eliminate the effect of the terminal conditions at the lower end of the annulus, with the result that the motion of the fluid in the annulus was practically the same as it would have been in an annulus of infinite length.

One of the cylinders was driven at known and constant speeds, and the moment transmitted to the other cylinder, which was suspended by a torsion wire, was measured for each speed. In some of the experiments the inner cylinder was suspended on the torsion wire, and the outer one revolved, and in others these conditions were reversed. Two sets of cylinders were used, giving annuli of one inch and half an inch width respectively. When the outer cylinder was the revolving one, it was found that, up to a certain speed, the transmitted moment increased as the first power of the speed. Above this speed there was a region where that moment was indeterminate between certain limits, and varied suddenly from one value to another at uncertain intervals. At higher speeds again the moment was perfectly determinate, but varied as a power of the speed higher than the square.

When the inner cylinder was the revolving one, none of these variations in the character of the function representing moment in terms of speed were observed. At not even the lowest speeds was the moment proportional to the first power of the velocity, but the whole series agreed fairly with the equation, moment = constant × velocity to the power of 1·8.

Returning to the experiments where the outer cylinder revolved, the coefficient of viscosity of water deduced from these experiments at speeds where the moment was proportional to the first power of the speed, was greater than Poiseuille's value, and the difference was greater with the one inch than with the half inch annulus. In some former experiments of the same kind where an annulus of about 0·2 in. was used, the value of the coefficient of viscosity obtained was very nearly the same as Poiseuille's.

Taken together, these experiments tend to show that there must be more than two forms of flow possible for a viscous fluid subjected to shearing force, and that long before anything like permanent eddying

is set up, the motion may depart from the purely lamellar one, which appears to hold in capillary tubes, although in the motion in question the resistance is still on the whole proportional to the first power of the speed.

Presents, November 21, 1895.

Transactions.

Adelaide:—Royal Society of South Australia. Transactions. Vol. XIX. Part 1. 8vo. *Adelaide* 1895. The Society.

Albany:—New York State Museum. Bulletin. Vol. III. Nos. 12—13. 8vo. *Albany* 1895. The Museum.

Amsterdam:—Koninkl. Akademie van Wetenschappen. Verhandelingen. 1e Sectie. Deel II. No. 7. Deel III. Nos. 1—4. 8vo. *Amsterdam* 1894–95; Verhandelingen. 2e Sectie. Deel IV. Nos. 1—6. 8vo. *Amsterdam* 1894-95; Verslagen van der Zittengen. Deel III. 8vo. *Amsterdam* 1895; Jaarboek. 1894. 8vo. *Amsterdam.*
The Academy.

Baltimore:—Johns Hopkins University. Circulars. Vol. XIV. Nos. 119, 120. 4to. *Baltimore* 1895. The University.

Bangor:—University College of North Wales. Calendar. 1895–96. 8vo. *Manchester* 1895. The College.

Basel:—Naturforschende Gesellschaft. Verhandlungen. Bd. XI. Heft 1. 8vo. *Basel* 1895. The Society.

Batavia:—Bataviaasch Genootschap van Kunsten en Wetenschappen. Notulen. Deel XXXII. Afl. 3—4. Deel XXXIII. Afl. 1. 8vo. *Batavia* 1894–95; Tijdschrift. Deel XXXVII. Afl. 6. Deel XXXVIII. Afl. 3—4. 8vo. *Batavia* 1894–95; Verhandelingen. Deel XLVII. Stuk 3. Deel XLVIII. Stuk 2. 8vo. *Batavia* 1894; Nederlandsch-Indisch Plakaatboek, 1602—1811. Deel XIII. 8vo. *Batavia* 1895; Dagh-Register gehouden int Casteel, Batavia. Anno 1665. 8vo. *Batavia* 1894. The Society.

Berlin:—Gesellschaft für Erdkunde. Verhandlungen. Bd. XXII. Nos. 6—7. 8vo. *Berlin* 1895; Zeitschrift. Bd. XXX. Nos. 3—4. 8vo. *Berlin* 1895. The Society.

Königl. Akademie der Wissenschaften. Abhandlungen. 1894. 4to. *Berlin;* Sitzungsberichte. 1895. Nos. 26—38. 8vo. *Berlin.* The Academy.

Berne:—Allgemeine Schweizerische Gesellschaft für die Gesammten Naturwissenschaften. Neue Denkschriften. Bd. XXXIV. 4to. *Zürich* 1895; Verhandlungen. 1894. 8vo. *Schaffhausen;* Compte Rendu des Travaux. 1894. 8vo. *Genève.*
The Society.